Unit II

SEMICONDUCTING MATERIALS

CONTENTS

2.10.Tunnel diode.

Definition

A tunnel diode is a simple p-n junction in which both p and n sided are very heavily doped with impurities.

It is an pn junction which exhibits negative resistance between two values of forward voltage (i.e., between peak-point voltage and valley point voltage).

Construction

It is basically a pn junction with heavy doping of p-type and n-type semiconductors.

This heavy doping gives a large number of majority carriers. As a result, the depletion layer becomes very narrow.

The symbol for the diode is shown in figure

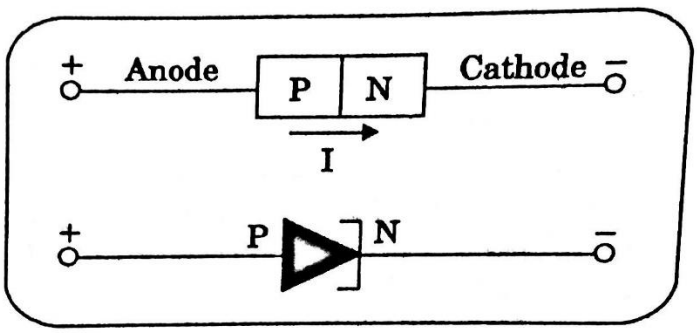

Fig 2.10.1 Symbol of tunnel diode

Such diodes are usually fabricated from germanium, gallium-arsenide (GaAs) and gallium antimonide (GaSb).

Working

The operation of the tunnel diode depends on the tunnelling effect.

The energy band diagram is shown in figure(a) without any forward applied voltage (V=0). There is a large mismatch between the energy levels of the electrons and the holes. As the forward voltage is increased, the energy level of the electrons shifts.

At a particular voltage V_p, the energy levels of the electrons and holes coincide. Now the electrons tunnel through barrier and falls into the holes (figure (b)).

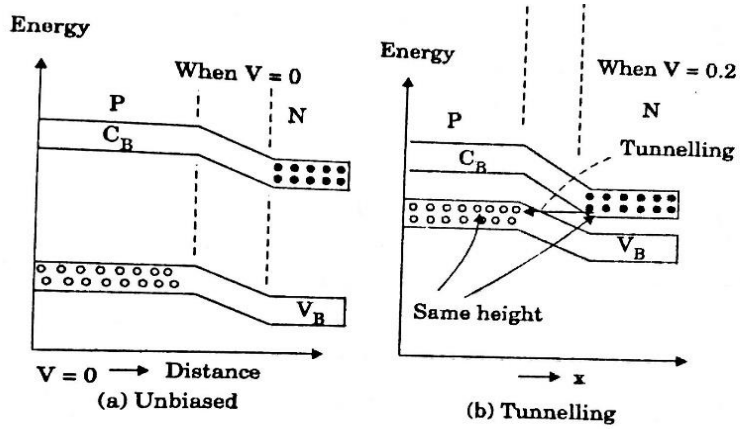

Fig 2.10.2Tunnel effect

The effect of electrons directly falling into the holes without climbing the potential hill is known as tunnelling.

As the voltage futher increases, the mismatch also increases and the current decreases. At a particular voltage V_v the current drops to a minimum value.

V-I Characteristics

The V-I characteristics is as shown in figure. The forward bias produces immediate conduction i.e., as soon forward bias is applied, the current flows.

The current quickly rises to its peak value I_p when the applied forward voltage reaches a vlue V_p (point A) as shown in figure.

When forward voltage is increased further, diode current starts decreasing till it reaches its minimum value called valley current I_p corresponding to valley voltage V_v (pont B). For voltages greater than V_v, current starts increasing again as in an ordinary junction diode.

The characteristics of the tunnel diode is obtained by superimposition of the tunnelling characteristics and the conventional diode characteristics,

As seen from figure, between the peak point A and valley point B, current decreases with increase in the applied voltage. This means that tunnel diode shows negative resistance in this region.

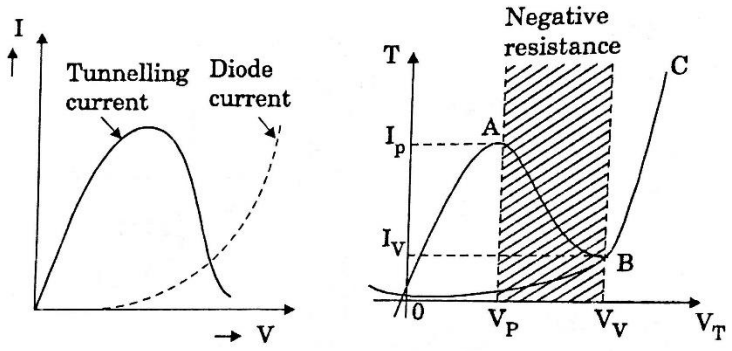

Fig 2.10.3. V-I Charateristics